



Low Cost, Single & Multi-Channel, Voltage-to-Frequency Converters

Preliminary Technical Data

AD7741/42

FEATURES

Synchronous Operation

Full-Scale Frequency Set by External System Clock

Single +5V Supply Operation

AD7741: Single-ended input

AD7742: 2 Pseudo-Differential inputs + 1 Differential, OR 2 Fully Differential inputs

Input Signal Range selectable via Gain pin

No user intervention required to achieve specified performance

Input Signal Range:

AD7741: 0V to +REF IN

AD7742: Unipolar: 0V to +REF IN or 0V to +REF IN/2

Bipolar: -REF IN to +REF IN or -REF IN/2 to +REF IN/2

Minimum External Components required

Low Power: 30 mW typ

AD7741: 8-Pin DIP, 8-Lead 0.15" wide SOIC packages

AD7742: 16-Pin DIP, 16-Lead 0.15" wide SOIC packages

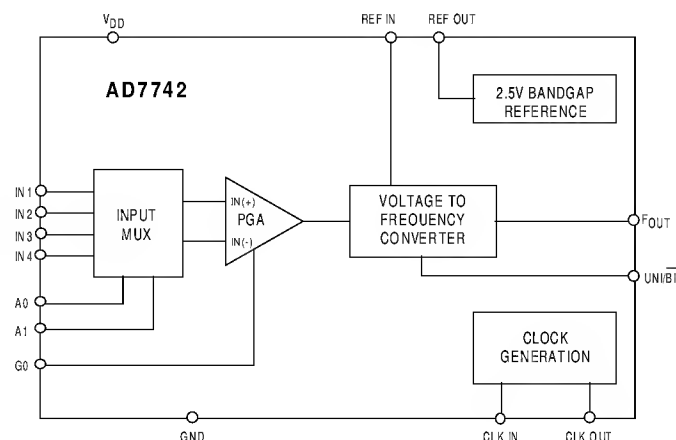
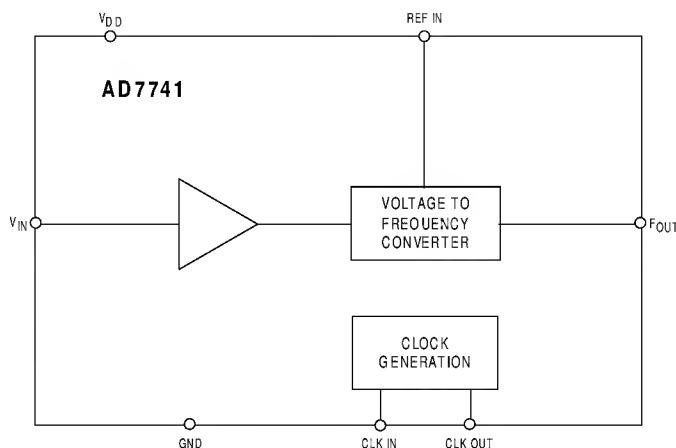
GENERAL DESCRIPTION

The AD7741 and AD7742 are a new generation of synchronous Voltage-to-Frequency Converters (VFC's). The AD7741 is a single-ended version in a small 8-pin DIP/SOIC package and the AD7742 is a multi-channel version in a 16-pin DIP/SOIC package. Small package, low cost, ease of use plus no user trims required to achieve specified performance were major design goals for these products.

The AD7742 contains an internal +2.5 V bandgap reference and offers two differential inputs or one differential and two pseudo-differential inputs. The AD7742 also allows the user the choice of pin-programming the channel and gain settings.

The AD7741 accepts a single-ended analog input range from 0 V to +REF IN and the AD7742 accepts differential analog input ranges from -REF IN to +REF IN. Both parts operate from a single +5 V supply consuming only 30 mW typical.

FUNCTIONAL BLOCK DIAGRAMS



PRODUCT HIGHLIGHTS

1. The AD7741 is a single channel, single-ended VFC. It is available in an 8-pin DIP and in an 0.15" wide 8-lead SOIC package.
2. The AD7742 is a multi-channel VFC whose internal settings (PGA & Channel Select) can be pin selected by tying certain package pins high or low. It is available in an 16-pin DIP and in an 0.15" wide 16-lead SOIC package.
3. Low Power, Single Supply Operation
The AD7741 and AD7742 operate from a single +5 V supply and consume only 30 mW.

Prelim H 11/97

Information furnished by Analog Devices is believed to be accurate and reliable. However, no responsibility is assumed by Analog Devices for its use, nor for any infringements of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of Analog Devices.

© Analog Devices, Inc., 1997

One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106, U.S.A.
Tel: 781/329-4700 Fax: 718/326-8703

AD7741—PRELIMINARY SPECIFICATIONS

($V_{DD} = +5\text{ V} \pm 5\%$, $GND = 0\text{ V}$, External Reference = $+2.5\text{ V}$; $XCLK_{IN} = 5\text{ MHz}$; All specifications T_{MIN} to T_{MAX} unless otherwise noted.)

Parameter ²	B Versions ¹	Y Versions ¹	Units	Test Conditions/Comments
ACCURACY				
Linearity Error				
$XCLK_{IN} = 200\text{ kHz}$	± 0.012	± 0.012	% of Span max.	
$XCLK_{IN} = 2\text{ MHz}$	± 0.012	± 0.012	% of Span max.	
$XCLK_{IN} = 5\text{ MHz}$	± 0.012	± 0.012	% of Span max.	
DC ACCURACY				
DC Input Current	± 1.0	± 1.0	nA typ	100nA max.
DC Power Supply Rejection Ratio	0.001	0.001	%/V max	
Offset Error			μV max.	
Offset Error Drift			$\mu\text{V}/^{\circ}\text{C}$ typ.	
Gain Error	± 0.5	± 0.5	% of Span max.	
Gain Error Drift			$\text{ppm}/^{\circ}\text{C}$ typ.	
ANALOG INPUT				
Input Resistance			k Ω min	
Input Voltage Range	0V to +REF IN	0V to +REF IN	Volts	
VOLTAGE REFERENCE				
REF IN				
Input Voltage	2.5	2.5	V nom	
Input Resistance			k Ω typ	
LOGIC OUTPUT (F_{OUT})				
Output High Voltage, V_{INH}	2.4	2.4	V min	I Source = 800 μA except for $XCLK_{OUT}$
Output Low Voltage, V_{INL}	0.4	0.4	V max	I Sink = 1.6 mA except for $XCLK_{OUT}$
LOGIC INPUTS ³				
ALL INPUTS EXCEPT $XCLK_{IN}$				
Input High Voltage, V_{INH}	2.0	2.0	V min	$V_{DD} = 5\text{ V} \pm 5\%$
Input Low Voltage, V_{INL}	0.8	0.8	V max	$V_{DD} = 5\text{ V} \pm 5\%$
Input Current, I_{IN}	± 10	± 10	μA max	$V_{IN} = 0\text{ V}$ to V_{DD}
Input Capacitance, C_{IN}	10	10	pF typ	
$XCLK_{IN}$ ONLY				
Input High Voltage, V_{INH}	3.5	3.5	V min	$V_{DD} = 5\text{ V} \pm 5\%$
Input Low Voltage, V_{INL}	0.8	0.8	V max	$V_{DD} = 5\text{ V} \pm 5\%$
Input Current, I_{IN}	± 10	± 10	μA max	$V_{IN} = 0\text{ V}$ to V_{DD}
Input Capacitance, C_{IN}	10	10	pF typ	
CLOCK FREQUENCY				
$XCLK_{IN}$	100 5	100 5	kHz min MHz max	For Specified performance
POWER REQUIREMENTS				
V_{DD}	+5	+5	V nom	$\pm 5\%$ for Specified Performance
I_{DD}	8	8	mA max	$V_{DD} = 5\text{ V} \pm 5\%$
Power Dissipation	40	40	mW max	Typically 30mW

NOTES

¹Temperature Ranges are as follows: B Version, -40°C to $+85^{\circ}\text{C}$; Y Version, -40°C to $+125^{\circ}\text{C}$.

²See Terminology.

³Guaranteed by design and characterization, not production tested

Span = Max output frequency - Min output frequency

Specifications subject to change without notice.

AD7742-PRELIMINARY SPECIFICATIONS

($V_{DD} = +5\text{ V} \pm 5\%$, $GND = 0\text{ V}$, External Reference = $+2.5\text{ V}$; $XCLK_{IN} = 5\text{ MHz}$; All specifications T_{MIN} to T_{MAX} unless otherwise noted.)

Parameter ²	B Versions ¹	Y Versions ¹	Units	Test Conditions/Comments
ACCURACY				
Linearity Error				
$XCLK_{IN} = 200\text{ kHz}$	± 0.012	± 0.012	% of Span max.	
$XCLK_{IN} = 2\text{ MHz}$	± 0.012	± 0.012	% of Span max.	
$XCLK_{IN} = 5\text{ MHz}$	± 0.012	± 0.012	% of Span max.	
Channel-to-Channel Isolation			dB typ	$V_{IN} \neq \text{kHz}$
DC ACCURACY				
DC Input Current	± 1.0	± 1.0	nA typ	100nA max.
DC Power Supply Rejection Ratio	0.001	0.001	%/V max	
Unipolar Offset Error			μV max.	
Unipolar Offset Error Drift			$\mu\text{V}/^\circ\text{C}$ typ.	
Unipolar Gain Error	± 0.5	± 0.5	% of Span max.	
Unipolar Gain Error Drift			ppm/ $^\circ\text{C}$ typ.	
Bipolar Offset Error	± 100	± 100	μV max.	
Bipolar Zero Error			μV max.	
Bipolar Gain Error	± 0.5	± 0.5	% of Span max.	
CMR			dB	
ANALOG INPUT				
Input Resistance			k Ω min	
Common Mode Range ⁴	-300mV to $V_{DD} - 2\text{ V}$	-300mV to $V_{DD} - 2\text{ V}$	Volts	
	$\pm\text{REF}/\text{Gain}$	$\pm\text{REF}/\text{Gain}$	Volts	Bipolar Input Range
Differential Input Voltage Range	0 to REF/Gain	0 to REF/Gain	Volts	Unipolar Input Range
VOLTAGE REFERENCE				
REF IN				
Input Voltage	2.5	2.5	V nom	
Input Resistance			k Ω typ	
REF OUT				
Output Voltage	2.4/2.6	2.4/2.6	V min/V max	2.5 V \pm 5%
Drift	100	100	ppm/ $^\circ\text{C}$ typ	
Line Regulation			$\mu\text{V}/\text{V}$ max	
Load Regulation			$\mu\text{V}/\text{mA}$ max	
Noise (0.1 Hz - 10 Hz)			μV (p-p) typ	
Output Resistance	100	100	k Ω typ	
Output Capacitance			pF typ	
LOGIC OUTPUT (F_{OUT})				
Output High Voltage, V_{INH}	2.4	2.4	V min	I Source = 800 μA except for $XCLK_{OUT}$
Output Low Voltage, V_{INL}	0.4	0.4	V max	I Sink = 1.6 mA except for $XCLK_{OUT}$
LOGIC INPUTS³				
ALL INPUTS EXCEPT $XCLK_{IN}$				
Input High Voltage, V_{INH}	2.0	2.0	V min	$V_{DD} = 5\text{ V} \pm 5\%$
Input Low Voltage, V_{INL}	0.8	0.8	V max	$V_{DD} = 5\text{ V} \pm 5\%$
Input Current, I_{IN}	± 10	± 10	μA max	$V_{IN} = 0\text{ V}$ to V_{DD}
Input Capacitance, C_{IN}	10	10	pF typ	
$XCLK_{IN}$ ONLY				
Input High Voltage, V_{INH}	3.5	3.5	V min	$V_{DD} = 5\text{ V} \pm 5\%$
Input Low Voltage, V_{INL}	0.8	0.8	V max	$V_{DD} = 5\text{ V} \pm 5\%$
Input Current, I_{IN}	± 10	± 10	μA max	$V_{IN} = 0\text{ V}$ to V_{DD}
Input Capacitance, C_{IN}	10	10	pF typ	
CLOCK FREQUENCY				
$XCLK_{IN}$	100	100	kHz min	For Specified performance
	5	5	MHz max	
POWER REQUIREMENTS				
V_{DD}	+5	+5	V nom	$\pm 5\%$ for Specified Performance
I_{DD}	8	8	mA max	$V_{DD} = 5\text{ V} \pm 5\%$
Power Dissipation	40	40	mW max	Typically 30mW

NOTES

¹Temperature Ranges are as follows: B Version, -40°C to $+85^\circ\text{C}$; Y Version, -40°C to $+125^\circ\text{C}$.

²See Terminology.

³Guaranteed by design and characterization, not production tested.

⁴The absolute input voltage on the different input pins must not go more positive than $V_{DD} - 2\text{ V}$ or more negative than $GND - 400\text{ mV}$. The common-mode voltage applies to those inputs which form differential pairs.

Span = Max output frequency - Min output frequency

Specifications subject to change without notice.

TIMING CHARACTERISTICS^{1, 2}

($V_{DD} = +5\text{ V} \pm 5\%$, $GND = 0\text{ V}$, External Reference = $+2.5\text{ V}$; $XCLK\ IN = 5\text{ MHz}$;
All specifications T_{MIN} to T_{MAX} unless otherwise noted)

Parameter	Limit at T_{MIN} , T_{MAX} (B Version)	Units	Conditions/Comments
F_{CLOCK}	100	kHz min	Clock Frequency
t_{HIGH}/t_{LOW}	5	MHz max	
	45/55	min	Clock Mark / Space Ratio
	55/45	max	
t_1	9	ns typ	CLK Edge to F_{OUT} Edge Delay
t_2	TBD	ns typ	F_{OUT} Rise Time
t_3	TBD	ns typ	F_{OUT} Fall Time

NOTES

¹Sample tested at $+25^\circ\text{C}$ to ensure compliance.

²See Figure 1.

Specifications subject to change without notice

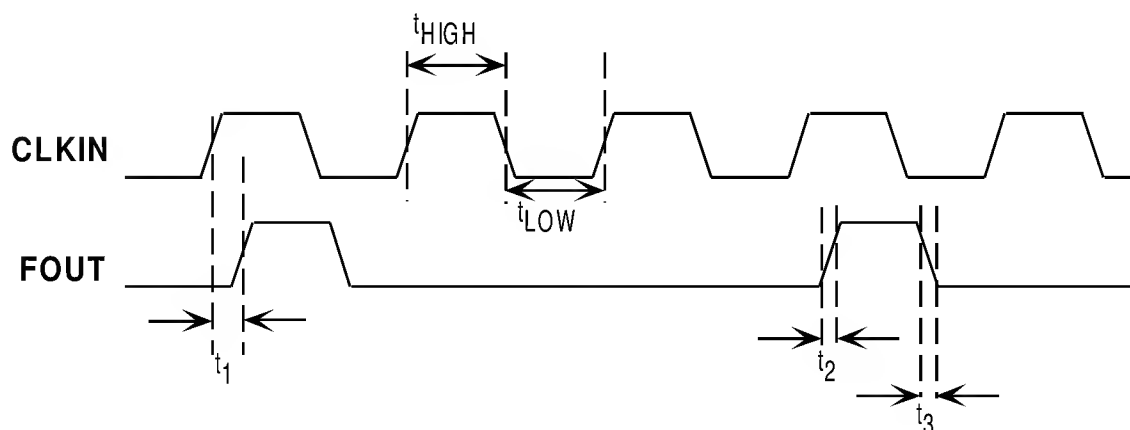


Figure 1. Timing Diagram

ABSOLUTE MAXIMUM RATINGS*

(T_A = +25°C unless otherwise noted)

V _{DD} to GND	−0.3 V to +7 V
Analog Input Voltage to GND	−5 V to +7 V
Reference Input Voltage to GND	−0.3 V to V _{DD} + 0.3 V
Digital Input Voltage to GND	−0.3 V to V _{DD} + 0.3 V
Operating Temperature Range	
Industrial (B Version)	−40°C to +85°C
Automotive (Y Version)	−40°C to +125°C
Storage Temperature Range	−65°C to +150°C
Junction Temperature	+150°C
Plastic DIP Package, Power Dissipation	450 mW
θ _{JA} Thermal Impedance (8-pin DIP)	125°C/W
θ _{JA} Thermal Impedance (16-pin DIP)	117°C/W
Lead Temperature (Soldering, 10 sec)	+260°C
SOIC Package, Power Dissipation	450 mW
θ _{JA} Thermal Impedance (8-Lead)	157°C/W
θ _{JA} Thermal Impedance (16-Lead)	74°C/W
Lead Temperature, Soldering	
Vapor Phase (60 sec)	+215°C
Infrared (15 sec)	+220°C

*Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those listed in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

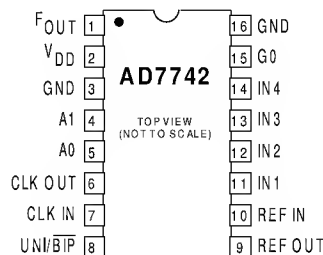
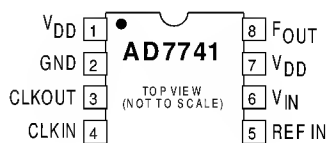
AD7741/42 ORDERING GUIDE

Model	Temperature Range	Package Option*
AD7741BN	−40°C to +85°C	N-8
AD7741BR	−40°C to +85°C	R-8
AD7741YR	−40°C to +125°C	R-8
AD7742BN	−40°C to +85°C	N-16
AD7742BR	−40°C to +85°C	R-16A
AD7742YR	−40°C to +125°C	R-16A

*N = Plastic DIP, R = SOIC.

PIN CONFIGURATION

DIP and SOIC



CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although these devices feature proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

AD7741 PIN FUNCTION DESCRIPTION

Pin No.	Pin Mnemonic	Description
1	V _{DD}	Positive supply voltage, +5 V \pm 5%.
2	GND	Analog Ground. Ground reference for Programmable Gain Amplifier, Voltage to Frequency Converter and Bandgap Reference.
3	CLKOUT	External Clock Output. When the master clock for the device is a crystal, the crystal is connected between CLKIN and CLKOUT. When an external clock is applied to CLKIN, CLKOUT provides an inverted clock signal. This clock must be buffered before being used to provide a clock source for a microprocessor, ADC or other system components.
4	CLKIN	External Clock Input. The master clock for the device can be provided in the form of a crystal or an external clock. A crystal can be tied across the CLKIN, CLKOUT pins. Alternatively, the CLKIN pin can be driven with a CMOS-compatible clock and CLKOUT left unconnected.
5	REF IN	Voltage Reference Input. A precision reference (e.g. REF192) is applied to this pin.
6	V _{IN}	Analog Input Channel. The analog input range is from 0V to REF IN. An input signal equal to 0V results in an output frequency of F _{OUT min} (5% of F _{CLOCK}) and an input of REF IN results in an output frequency of F _{OUT max} (45% of F _{CLOCK}).
7	V _{DD}	Positive supply voltage, +5 V \pm 5%.
8	FOUT	Frequency Output

AD7742 PIN FUNCTION DESCRIPTION

Pin No.	Pin Mnemonic	Description
1	FOUT	Frequency Output
2	V _{DD}	Positive supply voltage, +5 V \pm 5%.
3	GND	Analog Ground.
4	A1	Channel Select Input. This is used as a channel select input in conjunction with A0 to select one of four possible input channel configurations allowable.
5	A0	Channel Select Input. This is used as a channel select input in conjunction with A1 to select one of four possible input channel configurations allowable.
6	CLKOUT	External Clock Output. When the master clock for the device is a crystal, the crystal is connected between CLKIN and CLKOUT. When an external clock is applied to CLKIN, CLKOUT provides an inverted clock signal. This clock must be buffered before being used to provide a clock source for a microprocessor, ADC or other system components.
7	CLKIN	External Clock Input. The master clock for the device can be provided in the form of a crystal or an external clock. A crystal can be tied across the CLKIN, CLKOUT pins. Alternately, the CLKIN pin can be driven with a CMOS-compatible clock and CLKOUT left unconnected.
8	UNI/ $\overline{\text{BIP}}$	Unipolar/ $\overline{\text{BIPOLAR}}$ Input Select. This pin determines whether the device is to operate with differential bipolar input signals (common mode range: -300mV to (V _{DD} -2V)) or whether the differential analog input signals are always positive. With UNI/ $\overline{\text{BIP}}$ high, a differential analog input signal equal to 0 V results in an output frequency of F _{OUT min} (5% of F _{CLOCK}) and an input of REF IN/Gain results in an output frequency of F _{OUT max} (45% of F _{CLOCK}). With UNI/ $\overline{\text{BIP}}$ low, a differential analog input signal of -REF IN/Gain results in an output frequency of F _{OUT min} (5% of F _{CLOCK}) and an input of +REF IN/Gain results in an output frequency of F _{OUT max} (45% of F _{CLOCK}).
9	REFOUT	Voltage Reference Output. A +2.5V reference is provided at this pin. REF OUT has a low output impedance which makes it suitable for directly driving external circuitry.
10	REFIN	Voltage Reference Input. This defines the span of the VFC. For specified operation a +2.5 V reference is required at this pin. It can be tied to REF OUT directly or, if a precision reference is available, it can be applied to this pin.
11	IN1	Analog Input Channel 1. This is either a pseudo-differential input with respect to IN4 or it is the positive input of a differential analog input pair when used with IN2 (See Table I). In bipolar mode the differential analog input voltage range is \pm REF IN /Gain of the PGA. In unipolar mode the differential analog input voltage range is 0 to +REF IN /Gain.
12	IN2	Analog Input Channel 2. This is either a pseudo-differential input with respect to IN4 or it is the negative input of a differential analog input pair when used with IN1 (See Table I).
13	IN3	Analog Input Channel 3. This is the positive input of a differential analog input pair when used with IN4 (See Table I).
14	IN4	Analog Input Channel 4. This is either the common input for pseudo-differential inputs on IN1 and IN2 or it is the negative input of a analog input pair when used with IN3 (See Table I).
15	G0	Gain Select Input. This is used as a gain select input for the PGA to select one of two gains for the PGA.
16	GND	Analog Ground. Ground reference for Programmable Gain Amplifier, Voltage to Frequency Converter and Bandgap Reference.

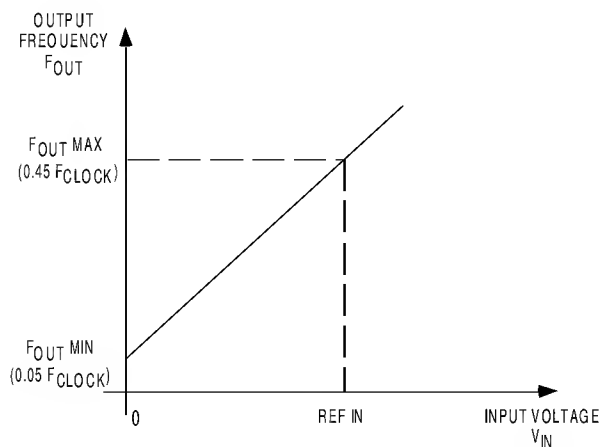


Figure 1. AD7741 Transfer Characteristic for Input Range from 0 V to REF IN.

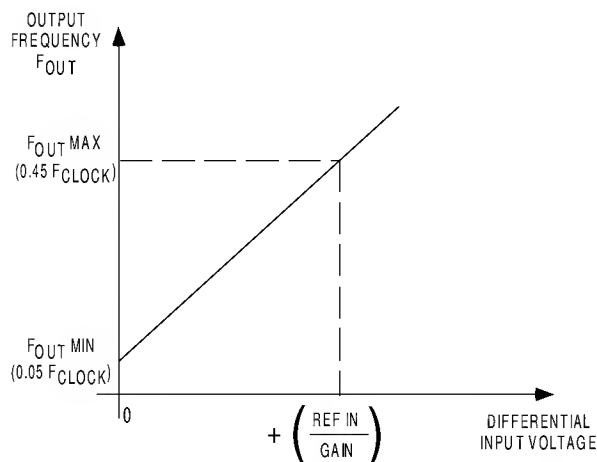


Figure 2. AD7742 Transfer Characteristic for Unipolar Differential input range: 0 V to REF IN/Gain; the input common mode Range must be between -300mV and $V_{DD} - 2V$. UNI/BIP pin tied to V_{DD} .

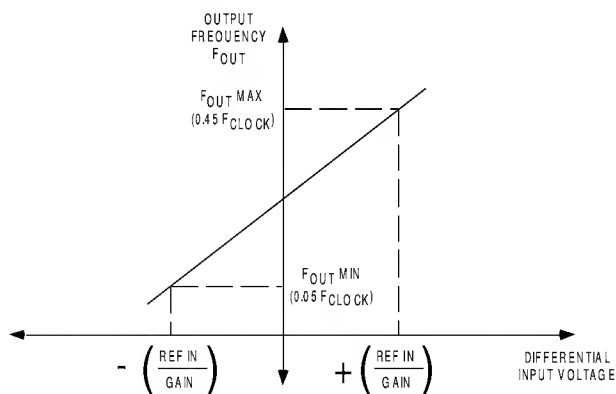


Figure 3. AD7742 Transfer Characteristic for Bipolar Differential Input Range: -REF IN/Gain to +REF IN/Gain (the common mode range is from -300mV to $V_{DD} - 2V$). UNI/BIP pin tied to GND.

TABLE I. AD7742 INPUT CHANNEL SELECTION

A1	A0	IN(+)	IN(-)	TYPE
0	0	IN1	IN4	Pseudo Diff
0	1	IN2	IN4	Pseudo Diff
1	0	IN3	IN4	Full Diff
1	1	IN1	IN2	Full Diff

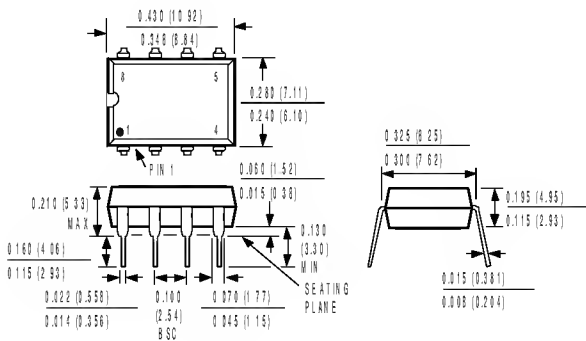
TABLE II. AD7742 GAIN SETTING SELECTION

UNI/BIP	G0	Gain Setting, G	Differential Input Voltage Span	
1	0	X1	0 to +2.5 V	0 to +REF IN/Gain
1	1	X2	0 to +1.25 V	0 to +REF IN/Gain
0	0	X1	-2.5 to +2.5 V	-REF IN/Gain to +REF IN/Gain
0	1	X2	-1.25 to +1.25 V	-REF IN/Gain to +REF IN/Gain

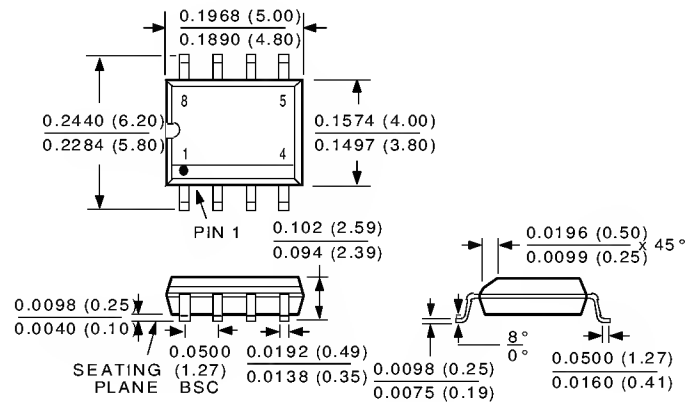
OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).

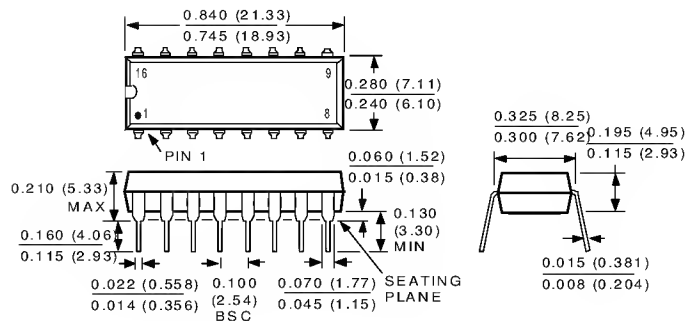
8-Pin Plastic DIP (N-8)



8-Lead SO (R-8)



16-Pin Plastic DIP (N-16)



16-Lead Narrow Body SO (R-16A)

